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Perforation and Bacterial Contamination of Microscope Covers in Lumbar Spinal Decompressive Surgery

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Key Words

Surgical infection · Operation microscope · Spine · Decompression

Abstract

Objective: To determine the integrity of microscope covers and bacterial contamination at the end of lumbar spinal decompressive surgery. **Materials and Methods:** A prospective study of 25 consecutive lumbar spinal decompressions with the use of a surgical microscope was performed. For detection of perforations, the microscope covers were filled with water at the end of surgery and the presence of water leakage in 3 zones (objective, ocular and control panel) was examined. For detection of bacterial contamination, swabs were taken from the covers at the same locations before and after surgery. **Results:** Among the 25 covers, 1 (4%) perforation was observed and no association between perforation and bacterial contamination was seen; 3 (4%) of 75 smears from the 25 covers showed post-operative bacterial contamination, i.e. 2 in the ocular zone and 1 in the optical zone, without a cover perforation. **Conclusions:** The incidence of microscope cover perforation was very low and was not shown to be associated with bacterial contamination. External sources of bacterial contamination seem to outweigh the problem of contamination due to failure of cover integrity.

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Introduction

Surgical site infections are reported to account for 38% of all surgical nosocomial infections [1]. They are associated with increased costs and lengths of hospital stay [2–4]. Seventy-seven per cent (77%) of acute mortalities in surgical patients with surgical site infections have been found to be infection related [1]. Post-operative surgical site infections have been shown to occur in 1–17% of cases [4–7] after spinal surgery. Several factors like diabetes mellitus, disseminated cancer, obesity, smoking, spinal fusion and the duration of surgery have been reported to be associated with an increased rate of surgical site infection in spinal surgery [4, 8, 9]. In an attempt to minimize the potential sources of surgical site infections, recent studies have pointed out the possible role of bacterial shedding by operation microscopes [10–12]. Bacterial contamination of the microscope cover was shown to be present in 12–44% of the samples taken at different sites of the cover [10, 12].

However, it has not been possible to determine if the cover contamination was caused by an external source (i.e. direct external contact like the surgeon's head or mask) or derived internally from the microscope itself. Thin sterile plastic foil covers are used universally as microscope covers. In the case of arthroscopic camera covers in orthopaedic surgery, it was shown that these foils are prone to dam-



Fig. 1. Zones for microbiological smears. * Main (surgeon's) ocular cover. ‡ Objective. ° Control panel.

age by manipulations during the surgical procedure, resulting in small defects of the foil [13]. This would allow contamination from the microscope itself. We presumed that small holes could also appear in microscope covers as a result of manipulation of the microscope which may lead to bacterial contamination of the surgical field. To our knowledge, this possible complication has not been studied systematically. Therefore, the aim of this study was to determine the integrity of microscope covers after spinal surgery and to assess the possible relationship between the incidence of cover perforations and the occurrence of bacterial contamination of the microscope covers.

Materials and Methods

A prospective study of consecutive spinal interventions with the use of a surgical microscope was performed. Plastic covers from 2 microscopes (M680; Leica Microsystems GmbH, Wetzlar, Germany, and OPMI Pentero; Carl Zeiss AG, Oberkochen, Germany) that



Fig. 2. Part of the microscope cover as removed after surgery. * Ocular cover. ‡ Objective. ° Foil covering the control panel.

were used during spinal surgery were collected (n = 25; M680: n = 2, OPMI Pentero: n = 23). As recommended by the manufacturers, Wild Leica 137/380 covers were used for the Leica microscope and OPMI Drapes Carl Zeiss covers were used for the Zeiss microscope. Covers were draped by a scrub nurse and the operating surgeon together, and both followed the standard aseptic technique. Gloves were changed after fitting of the lens cover. This study was conducted in compliance with the Helsinki Declaration and in accordance with the guidelines of the institutional ethics committee.

Patients/Intervention

Twenty-five lumbar spinal decompression procedures in 25 patients from October 2012 to December 2012 were prospectively included in this study. A sample size of 25 covers was chosen as a previous study on arthroscopic covers reported a perforation rate of 0.74, suggesting a probability of 0.0005 of observing no tears in 25 covers [13]. The involved doctors were experienced spinal surgeons who had performed over 200 spinal surgeries per year with the use of a surgical microscope at the authors' institution. Intravenous cefazolin was given as an antibiotic prophylaxis 30 min before skin incision. Surgery was performed in a laminar airflow operating facility.

Assessment of Microscope Cover Contamination

In order to check for contamination originating from external sources (i.e. direct contact with the surgeon's head or mask), bacterial contamination of the microscope covers was assessed after encasing the microscopes. Microbiological smears were taken from each of the covers divided as described above [objective zone, main (surgeon's) ocular zone and control panel zone] (fig. 1) before the start of the surgical procedure. After the surgery and before remov-

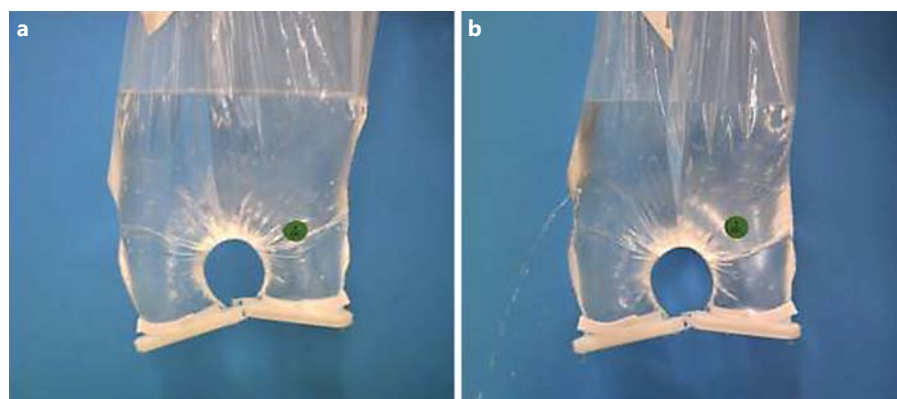


Fig. 3. Cover integrity testing setup. Ocular part of the cover filled with water. **a** No perforation. **b** Water leakage due to a perforation ≤ 1 mm in diameter.

al of the covers, smears were taken at the same locations again. To serve as a positive control, 2 smears were taken from each zone of an uncovered microscope. All smears were obtained using sterile culture swabs (eSwab; COPAN, Brescia, Italy). In a blinded manner, the swab was subsequently assessed using a standard semi-quantitative technique in laminar flow hoods. Swabs were streaked on one third of a 5% sheep blood Columbia agar plate (BioMérieux, Geneva, Switzerland) and then placed in Luria Bertani broth (Sigma) for enrichment for 72 h. With a disposable sterile loop, 2 successive dilutions were obtained by further streaking the initial inoculum on the agar plates over the remaining two thirds in succession, using a new loop for each streaking manoeuvre. The plates were then incubated at 37°C for 48 h, after which they were assessed for colony growth. After 72 h, the liquid enrichment medium was processed on agar plates identical to the agar plate method described above. Gram stains were used for morphology and Gram classification. Bacteria were assessed for catalase reactivity and staphylococcal agglutination. Some subcultures were further identified using the RapID Staph Plus System (BioMérieux).

Assessment of Microscope Cover Integrity

In order to check for internal contamination originating directly from the microscope itself, the foil integrity of the microscope covers was assessed. Immediately after surgery, the cover was cut circumferentially just above the strap closest to the microscope head and the cover was then carefully removed from the microscope (fig. 2). All covers were tested for perforations. Pre-existing openings for the oculars and the objective were closed water-tight with plastic clamps before testing. The covers were divided into 3 zones: an objective zone, a main (surgeon's) ocular zone and a control panel zone (fig. 1, 2). The covers were fixed in a custom-made testing device and the parts belonging to the zones mentioned above were filled with water up to a level of 25 cm. The presence of water leaks and their localizations were documented (fig. 3). As previously described for arthroscopic covers [13], holes in the plastic covers were classified as small (identified by water leakage but with no hole visible to the human eye), medium (hole ≤ 1 mm in diameter) and large (hole > 1 mm in diameter).

Statistical Analysis

To detect relationships between the occurrence of perforations or bacterial contaminations and the duration of surgery, the latter

Table 1. Duration of surgery

		Duration		Total
		< 1 h (n = 6)	> 1 h (n = 19)	
Perforation ^a	yes	0	1	1
	no	6	18	24
Postoperative contamination ^b	yes	0	3	3
	no	6	16	22

^a Fisher's exact test: $p = 1$. ^b Fisher's exact test: $p = 0.554$.

was divided into durations ≤ 1 h and > 1 h. Nominal variables were then were associated in crosstabs with Fisher's exact tests using SPSS for Windows 17.0 (SPSS, Chicago, Ill., USA). $p < 0.05$ was considered statistically significant.

Results

The mean duration of the operations was 89 ± 31 min (range 48–153). No perioperative complications were observed; in particular, there was no post-operative surgical site infection.

Bacterial Microscope Cover Contamination

Of the 25 covers, 3 (12%) showed post-operative bacterial contamination: 2 (8%) in the ocular zone and 1 (4%) in the objective zone. No significant relationship was detected between duration of surgery > 1 h and presence of a post-operative bacterial contamination (table 1; $p = 0.554$).

Though serving as a negative control, 6 of 25 covers showed pre-operative contamination [2 each in the ocular, control panel and objective zones; i.e. 6/75 (8%) pre-

operative smears] that was not reproducible post-operatively. Six of 6 positive controls taken directly from the uncovered microscope were positive.

Most isolated microorganisms (pre-operative, post-operative and control) were coagulase-negative staphylococci (*Staphylococcus capitis* and *S. epidermidis*). In 2 pre-operative smears (1 in the ocular zone and 1 in the objective zone), *Micrococcus* species were detected. In all cases, growth was only seen after enrichment, implying bacterial concentrations of 1–100 microorganisms/ml. No bacteria were detected when applying the swabs directly on agar.

Microscope Cover Integrity

Of the 25 covers, 1 (4%) perforation ≤ 1 mm in diameter in the control panel area was observed. This cover showed no bacterial contamination post-operatively. No significant relationship was detected between duration of surgery > 1 h and presence of a perforation (table 1; $p = 1$).

Discussion

Only 1 small perforation in 1 of the 25 covers was observed, which was, however, not associated with bacterial contamination. The removal procedure could have caused the lesion. Three of the 75 smears from a total 25 covers showed post-operative bacterial contamination, i.e. 2 in the ocular zone and 1 in the objective zone, without proof of a cover perforation. These numbers must be interpreted with caution, though, as 6 of the 75 pre-operative smears (negative control) were positive as well. The latter implies a possible high rate of false positives for all smears. In contrast, as all smears that were taken directly from the uncovered microscope (positive control) were positive, the rate of false negatives was low.

It is therefore unlikely that the bacterial contamination of the covers was facilitated through lesions in the cover foil. Apparently, this finding contradicts the hypothesis of internal contamination of the covers and supports the hypothesis of an external source of bacterial contamination (i.e. the surgeon or the nurse). The 4% rate of contamination in our study was smaller than those published previously (12–20% bacterial contamination of microscope covers) [10–12]. Tronnier et al. [11] reported contamination of the lens cover in 12% of cases and Bible et al. [12] reported contamination rates of 12–20% in each of the areas that are comparable to our study. The study by Tronnier et al. [11] was conducted 25 years ago and used different covers with different sterility standards,

which might explain the higher bacterial contamination rate. Bible et al. [12] used OPMI Drapes (Carl Zeiss AG), as in the vast majority of our cases. In contrast to our study, however, they performed their interventions in a non-laminar flow operating room. It remains unclear whether a laminar flow reduces the bacterial density in the air near the operation field. Two of 3 post-operative cover contaminations were observed in the ocular zone, which are most likely explained by shedding of dander from the face or by accidental touching of the unsterile area when adjusting the ocular focus during surgery [12].

There is no clear explanation for the high rate of pre-operative bacterial contamination of the covers. Post-sampling contamination during processing of the swabs is unlikely, as this was performed in a certified laboratory with an appropriate infrastructure (e.g. laminar flow hoods). Post-sampling contamination in the operation room is possible but would not explain the asymmetric (pre-/post-operative) distribution of bacterial growth.

Nevertheless, the bacterial burden was very low since bacteria were only detected after using enrichment media. In addition, the rate of contamination was smaller than in previous studies on bacterial contamination of microscope covers [10–12].

True contamination due to impaired sterility provided by the manufacturer or incorrect fitting of the cover is unlikely as we can assume a good sensitivity of the microbiological smears (all positive controls were positive) and bacterial growth was not reproducible in the same regions post-operatively in any of the cases.

The use of microscopes in spinal surgery has become standard. To date, there is no evidence of a superiority of clinical outcomes with the use of a microscope compared to the ‘open’ traditional technique. Future studies should be directed towards improving the design of these microscopes. As this study found external sources to be the main reason for bacterial contamination, new microscopes with integrated monitor systems [14] and touch screen technology might reduce potential causes of contamination. These technologies would decrease the amount of uncontrolled contact between the surgeon and the microscope cover. Knowledge about the source of bacterial contamination of foil covers is also important for designing covers for other equipment used in the intra-operative setting (e.g. portable CT scanners [15]).

A limitation of this study is that its prospective nature possibly introduced the problem of an observer effect. In this case, perforations might have been prevented because the study increased the attention of the surgical team. It is the authors’ conviction, however, that surgeons

using operative microscopes are always careful in their handling. No smears were taken from the 'overhead' area of the microscope covers that had been found to be prone to contamination during surgery [12], probably because this is mainly a problem of draping the cover and microscopes with air evacuation to remove the air between the microscope and the drape, which already have been suggested. Another limitation of this study resides in the fact that no post-operative surgical site infections were observed. Thus, the link between infection and microscope cover contamination cannot be proven or even evaluated by this study. An association between the use of operative microscopes and bacterial shedding into the operation field, however, has been reported in the literature before [10].

Conclusions

The incidence of microscope cover perforation as well as bacterial contamination was very low. The occurrence of cover perforation was not shown to be associated with bacterial contamination. External sources of bacterial contamination seem to outweigh the problem of contamination due to failure of cover integrity.

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